A Note on Hurricane Able of 1952

L. Sherman and I. Carino

Introduction: In a previous paper (Sherman, 1953) it has been proposed that hurricane reconnaisance procedures be modified so as to provide data for the location not only of the eye of a hurricane but of the associated hyperbolic point as well. Some doubt has been expressed as to the practicability of an analysis such as has been proposed. In that paper an isolated map was shown, establishing the possibility of such an analysis; however no systematic analysis of a "complete hurricane" (that is, including the hyperbolic point at each stage) was available as an illustration. It is the primary purpose of this paper to present such an analysis. For this purpose hurricane Able of the Atlantic season of 1952 seemed most suitable. Before 1952 we at F.S.U. did not have access to data from the hurricane teletype network, and Able, of all of the 1952 hurricanes, has the most favorable track from the point of view of station coverage in the expected track of its hyperbolic point.

The Analyses: In figure one, we have summarized the tracks of the cyclonic indraft points and the hyperbolic points taken from the analyses performed independently by each of us. In each case, the positions given by Ross (1952) for hurricane ABLE were accepted. By the application of a common technique, two sets of maps were analyzed for every synoptic map time. Their agreement is a measure of the adequacy of the data. Direct streamline analysis, the "fairing in" of streamlines so as to agree with the carefully plotted arrows was the method used. The analysis was made in stages.

The streamlines were first sketched on the basis of the strong winds alone. Then the analysis was extended into the regions reporting light winds. The mode of analysis in the neighborhood of the hyperbolic point can be clarified by reference to a sketch. Figure 2 is a model of a cyclonic indraft embedded in an easterly current. Note that the wind flows at stations marked 1, 2, and 3 are converging with those of 4, 5, and 6. The line towards which they converge is known as the asymptote of convergence. The asymptote of divergence on the other hand, is clearly indicated by the diverging wind flow as evidenced by the reports from stations 7, 8, 9, and 10. However, it will be noted that in a number of instances in the study of hurricane ABLE, such a distinct location was not possible due to the inadequacy of available data in the vicinity of the hyperbolic point. Furthermore, some of the winds had to be neglected since they were affected by local factors. Often it was possible to locate one of the asymptotes of convergence or divergence and but half of the other. Thus, referring to Figure 2, wind pairs (3, 6), (2, 5) and (9, 7) might be available but no data from the region of wind (8, 10) might exist. Nevertheless the hyperbolic point would be fairly well located. Occasionally, there were cases when the position of the hyperbolic point had to be carried on by pure extrapolation due to the scarcity of surface reports.

The asymptotes of convergence and divergence were located on the basis of the available wind reports and here again, greater weights were given to stronger winds, which were disregarded only reluctantly. Directions of light winds, particularly if they differed from the directions of nearby strong winds, were readily ignored for the reason that they are probably due to local factors such as the effect of land and sea breeze, mountain or valley breeze or orography. Of course account was taken of the kinematic necessity for the hyperbolic point of calm and of the empirical fact that the hyperbolic point at the surface is generally in a broad region of light winds (broad as compared to the light wind area around the cyclonic indraft point).

A set of surface streamline maps, together with a brief comment on those winds exceeding 8 knots that were disregarded in the neighborhood of the singular points is presented in Appendix A. No further explanations will be offered for the ignoring of directions of winds of speeds 8 knots or less.

We analyzed the wind field at the reconnaissance flight level (about 1000 feet for an under-the-cloud flight) for the two days for which such flight data was available. No flights were made once the storm entered the coast. The positions of the hyperbolic point at this level for these days are indicated in figure 3. In that figure, several positions have been entered for higher level maps as well. The upper wind maps upon which these positions are based are shown in Appendix B.

Conclusions: The tracks shown in figure one are in sufficient agreement to make it at least plausible that it is practicable to track the hyperbolic point as well as the cyclonic-indraft point of a hurricane. Once this is done, the disturbance has an orientation. This may be of aid in the reaching of a decision as to the direction of motion of the storm. Thus Ross [1952], investigating the warm tongue steering effect [Simpson, 1946], stated, "The path that the storm might follow is not definitely indicated by (a map for 0300 GCT on Aug 30)". It is of course evident from our track charts that the storm had definitely recurved by this time (note the great change in its orientation between 0030 GCT and 0630 GCT). It should be added in fairness that Ross' comment applied only to the application of the particular technique mentioned and, further, that the operational forecasters in Miami had already forecast recurvature by this time (oral communication from Mr. Grady Norton).

It is not the purpose of this note to show that directions of storm movement can be determined from such an analysis of the surface data. It is very possible that this will not be true in general. One could easily visualize the surface hyperbolic point "lagging behind" as the upper air parts of the disturbance turned. In such a case the recurvature would precede the surface indications. The study of a single storm cannot establish a pattern. Nor has any consideration been given to the slight alterations in orientation which occur as the storm nears and crosses the coast. Changes in orientation of the cyclonic indraft and hyperbolic points are to be expected in connection with changes in the relative strengths the cyclonic and indraft components of the wind field (Sherman, 1950). Our only purpose has been to arouse interest in this sort of analysis and to indicate its feasibility.

A similar analysis of the pressure field (in which both the low and associated col are tracked) is possible in theory. However in practice it is felt that over the open sea, pressure data will not be adequate. Also, at upper levels, the pressure observations taken from aircraft are not likely to be sensitive enough to pinpoint the col. Hence while we do not reject this line of attack, at present we are concentrating on the wind field.

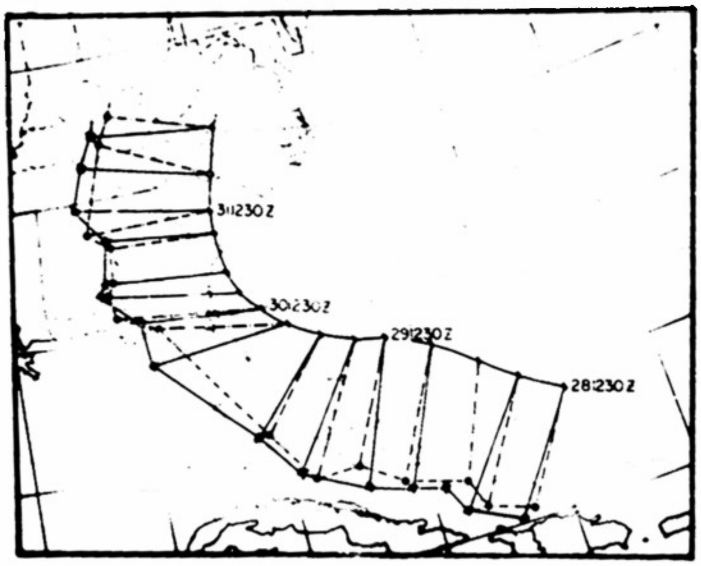


FIGURE 1

Legend

Position of the hurricane every 6 hours

Shermon's position of the hyperbolic point

Cariño's position of the hyperbolic point

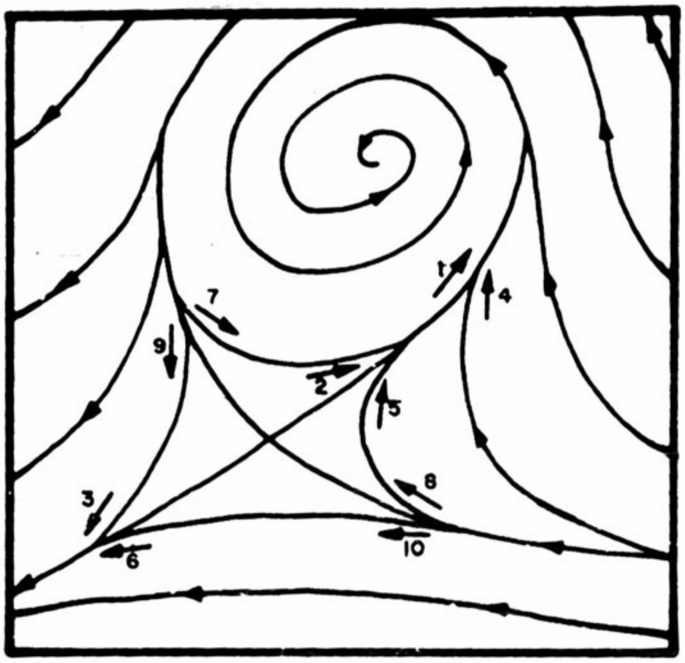


FIGURE 2

A typical cyclonic indraft and its corresponding hyperbolic point.

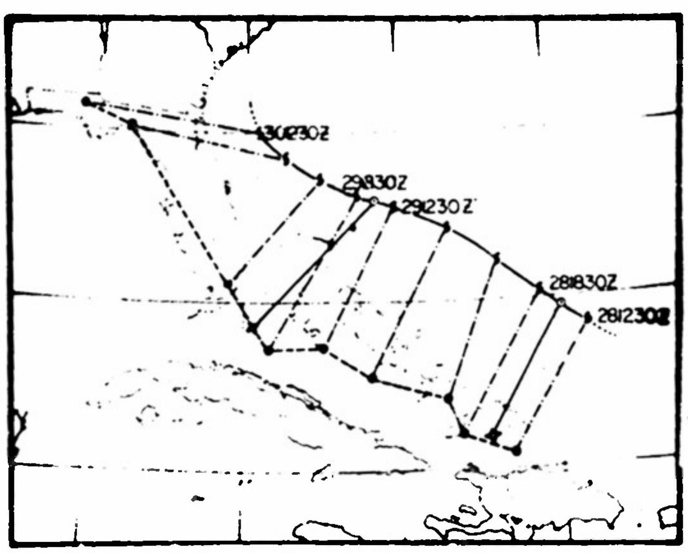


FIGURE 3

Legend

Surface hurricane position every 6 hours

Hurricane position at 1000 feet at 1500 GMT

Position of the surface hyperbolic point

Position of the hyperbolic point at 1000 ft

Appendix A: Surface Chart.

August 28 (1230Z) The flow over the open Caribbean (included in our working maps but not reproduced in these sectionals) aided in the location of the hyperbolic point on this map and on the others during the early part of the track.

August 28 (1830Z) The wind reported by the ship at about 25 N, 74 W was ignored in favor of the nearby winds. This ship also reported an erroneous wind on the next map.

August 29 (0030Z) No further comment.

August 29 (0630Z) The hyperbolic point was placed largely from continuity.

August 29 (1230Z) The north wind at Great Abaco Island (26°16'N 77°05'W) was ignored.

August 29 (1830Z) In view of the ship wind reports at about 28 N 77.0 W and 29 N 77.5 W, we would place the cyclonic indraft center about 1 degree of latitude to the South of the position indicated (the one given by Ross 1952).

August 30 (0030Z) No comment

August 30 (0630Z) Two winds in the cyclonic indraft circulation on the east coast of Florida had been ignored. The southern branch of the anticyclonic hyperbolae of the hyperbolic point is not fixed by data. However, the other three locate it at least approximately.

August 30 (1230Z) No comment.

August 30 (1830Z) There are some winds in the mid Gulf which on this and the next map seem erratic. However, these observations are well away from the hyperbolic point of interest to us.

August 31 (0030Z) No comment.

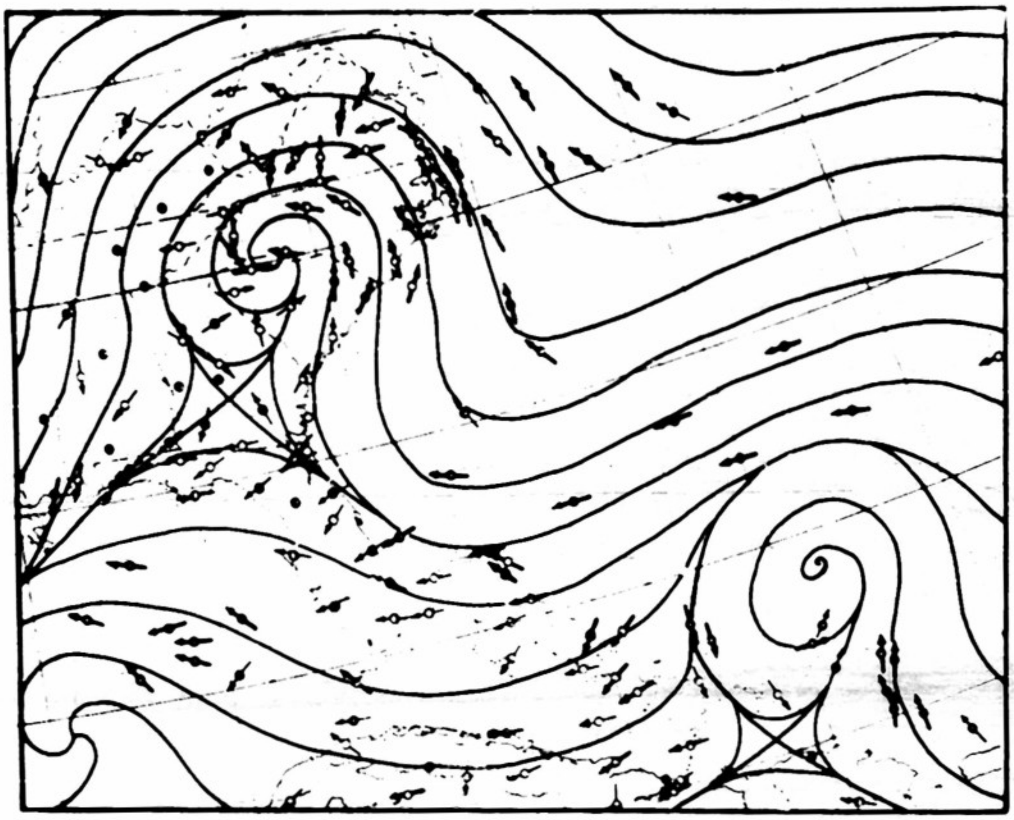
August 31 (0630Z) The eastern parts of the asymptotes of convergence and divergence are reasonably well fixed. These, with continuity, suffice to locate the hyperbolic point.

August 31 (1230Z) The same comment as the previous map with the addition that the northern and the southern sectors of the hyperbolic point are here better determined.

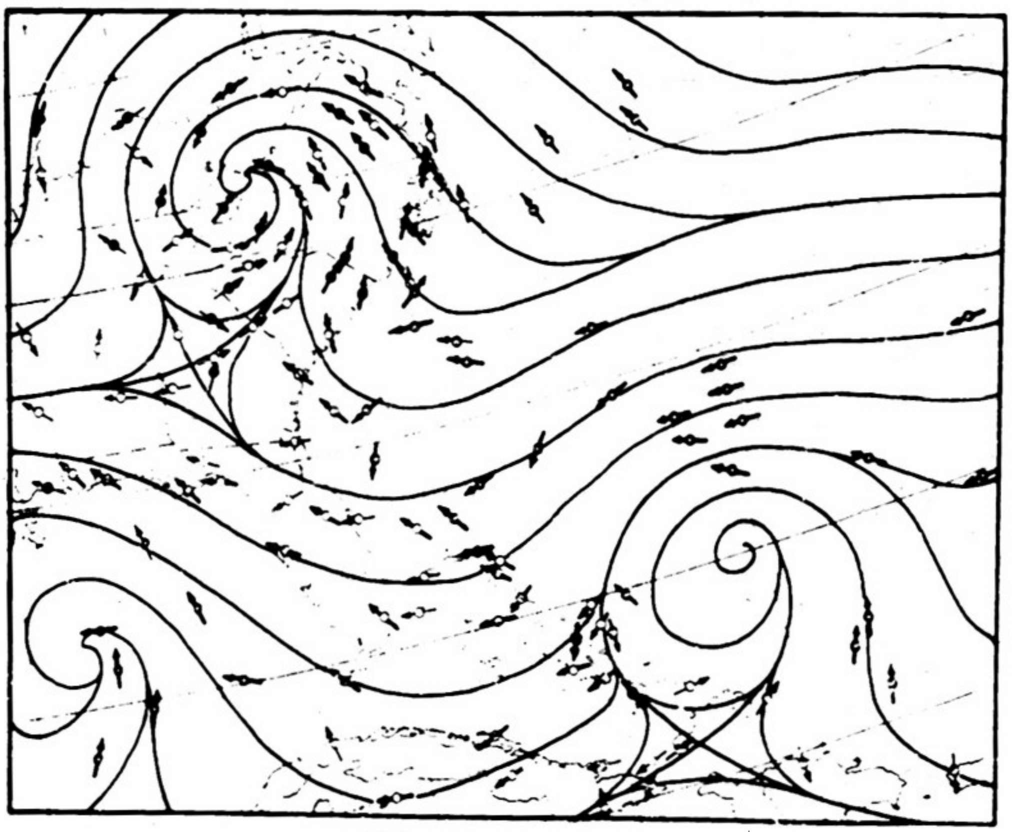
August 31 (1830Z) The west wind at Knoxville, Tennessee is in the mountains and presumably orographically affected. This is a good fix of the hyperbolic point.

September 1 (0030 Z) The winds near the hyperbolic point are mostly less than 8 knots; nevertheless, this is a fairly good fix (save for the Southeast portion which is in the mountains).

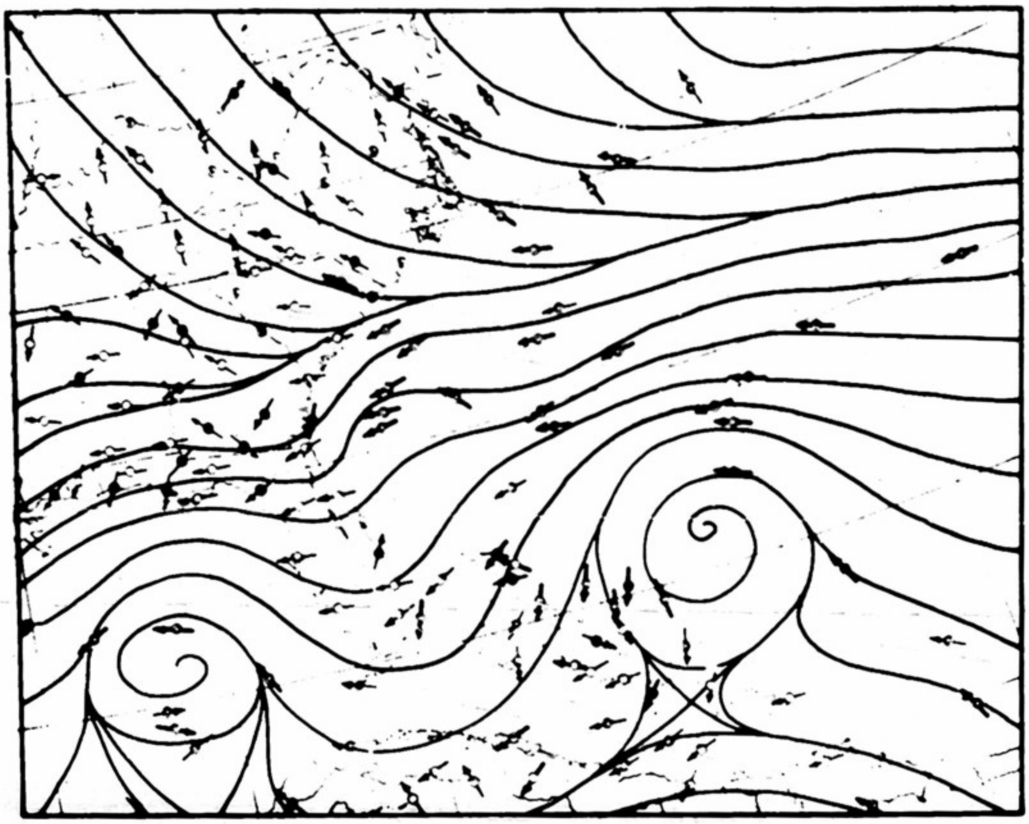
APPENDIX A. SURFACE STREAMLINE CHARTS



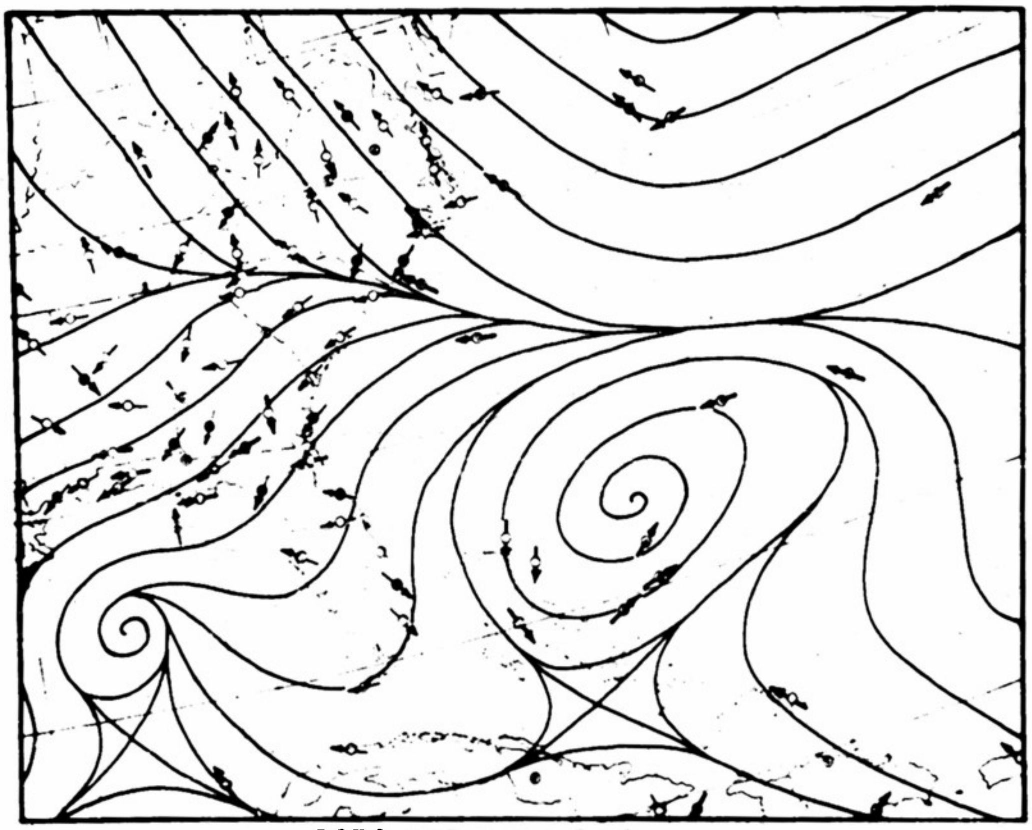
1230 GMT AUGUST 28



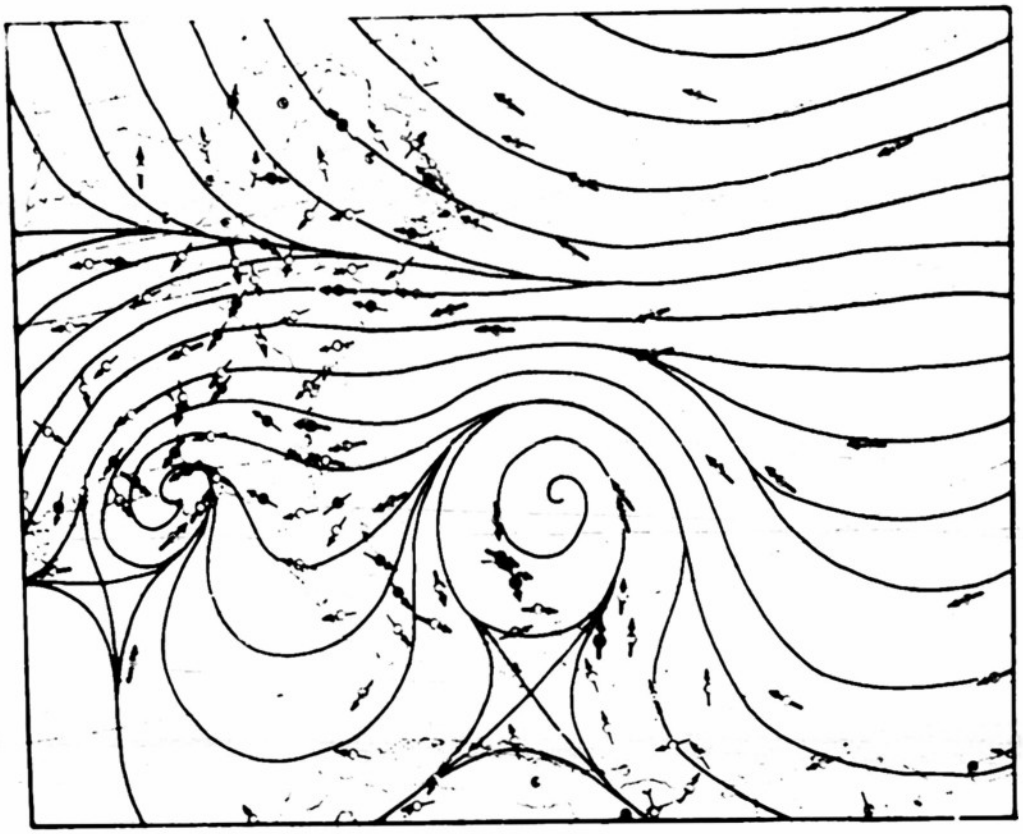
1630 GMT AUGUST 28



0030 GMT AUGUST 29



0630 GMT AUGUST 29



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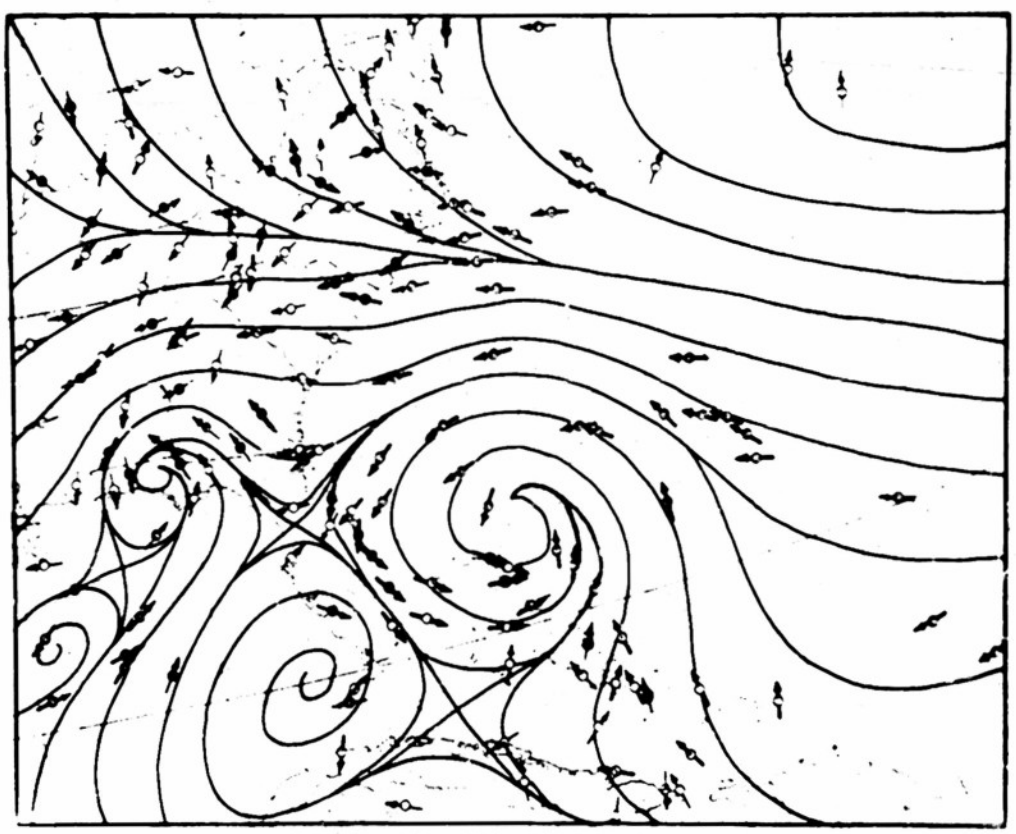
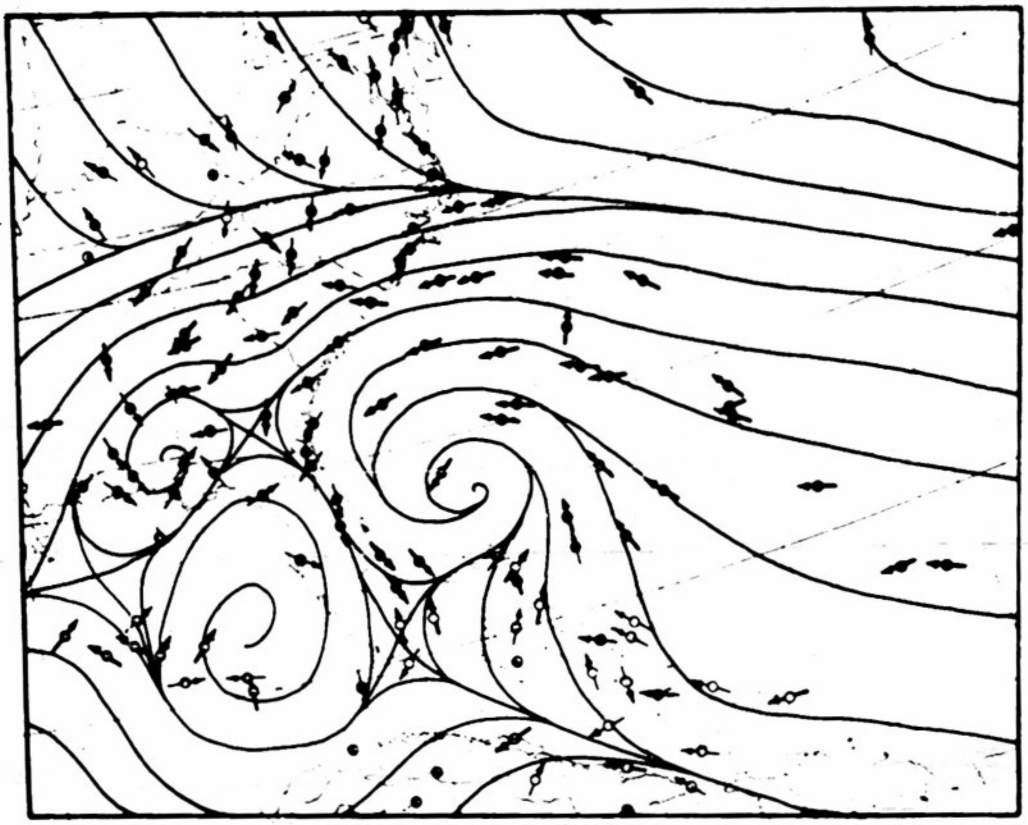
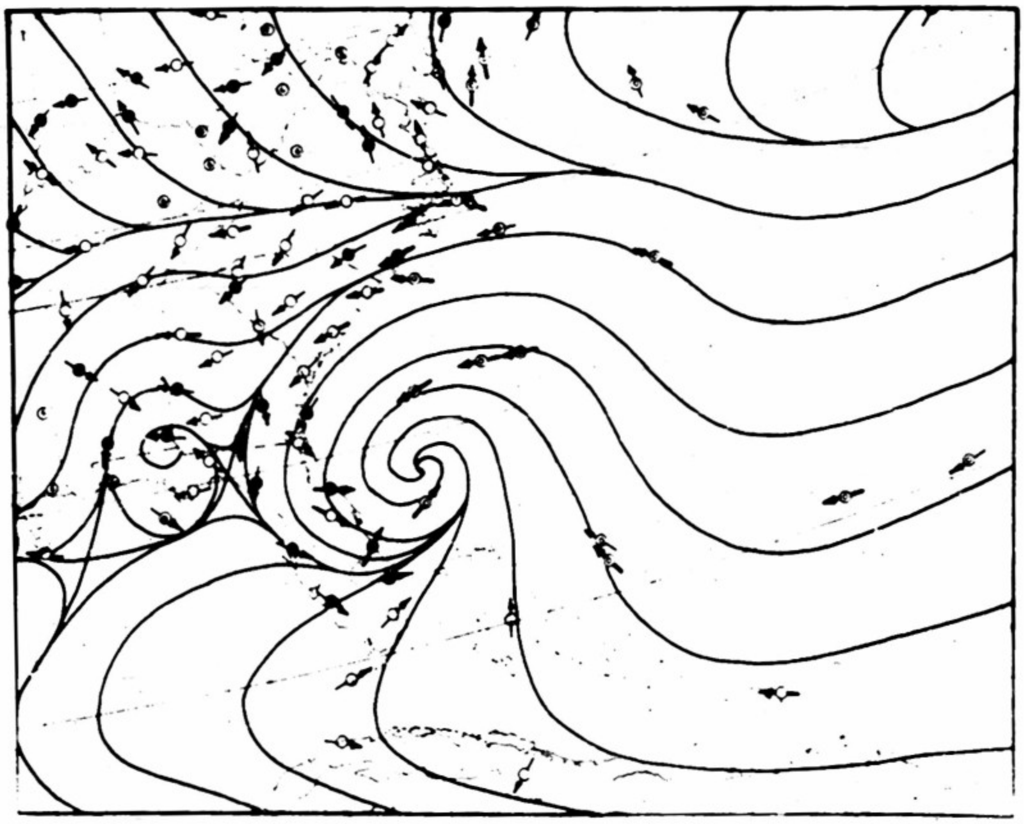


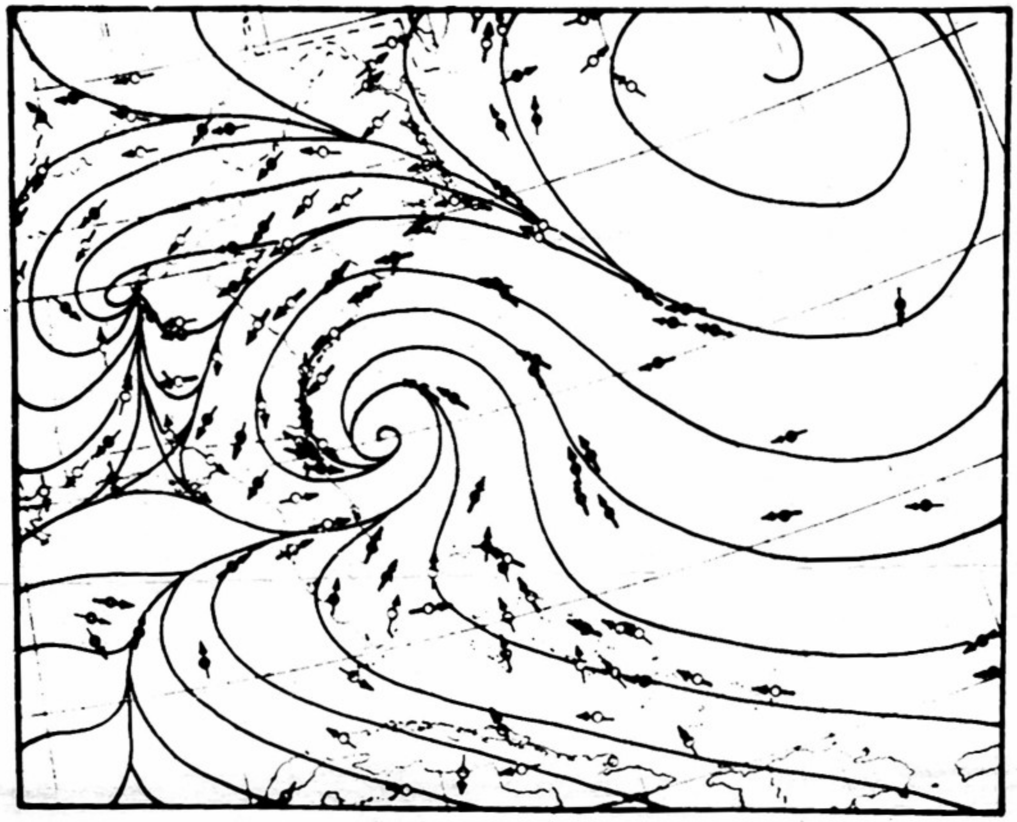
1830 GMT AUGUST 29



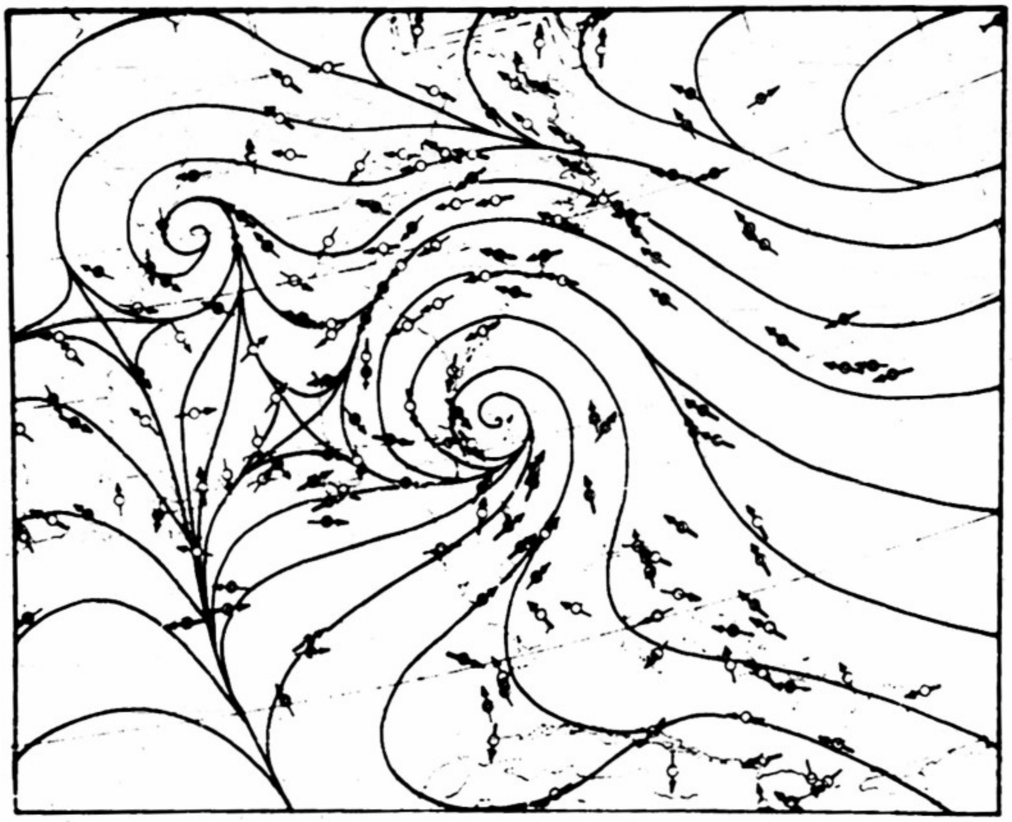
0030 GMT AUGUST 30



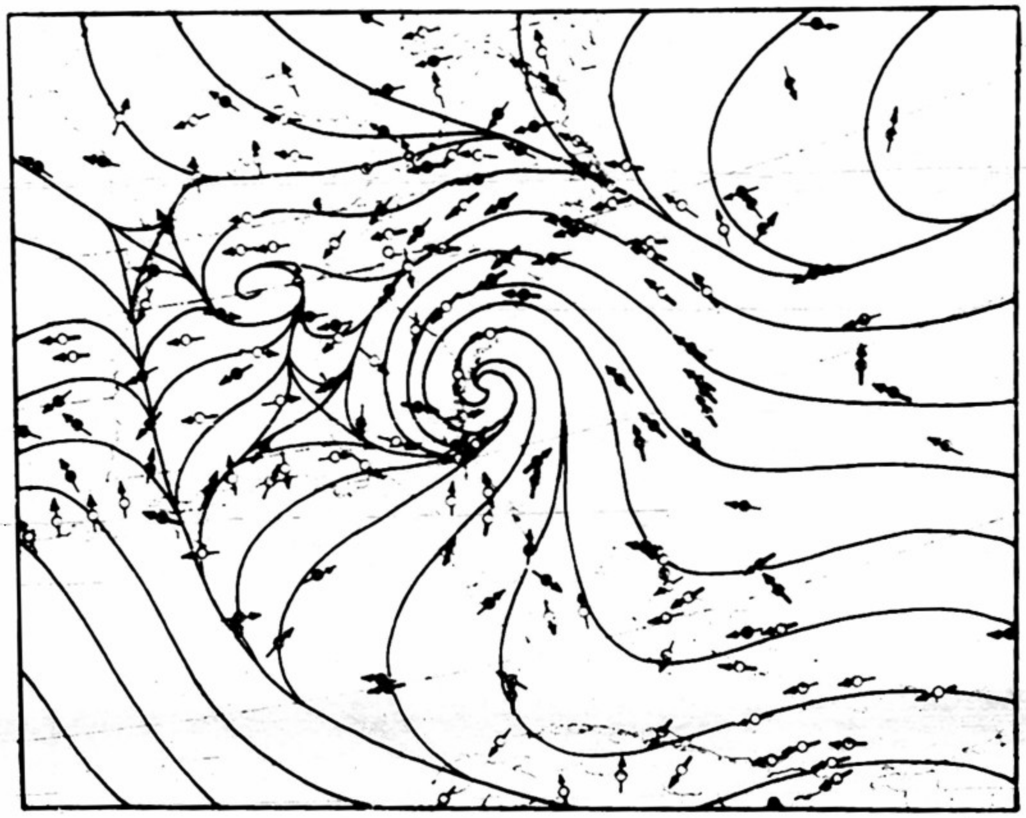
0630 GMT AUGUST 30



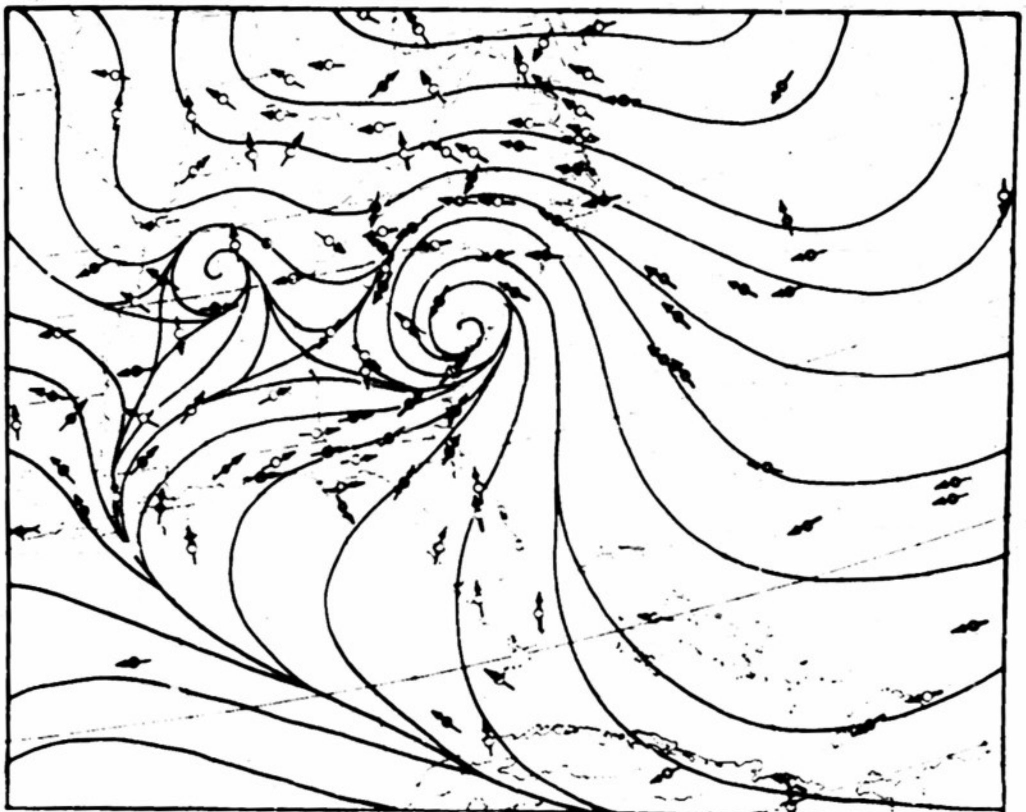
1230 GMT AUGUST 30



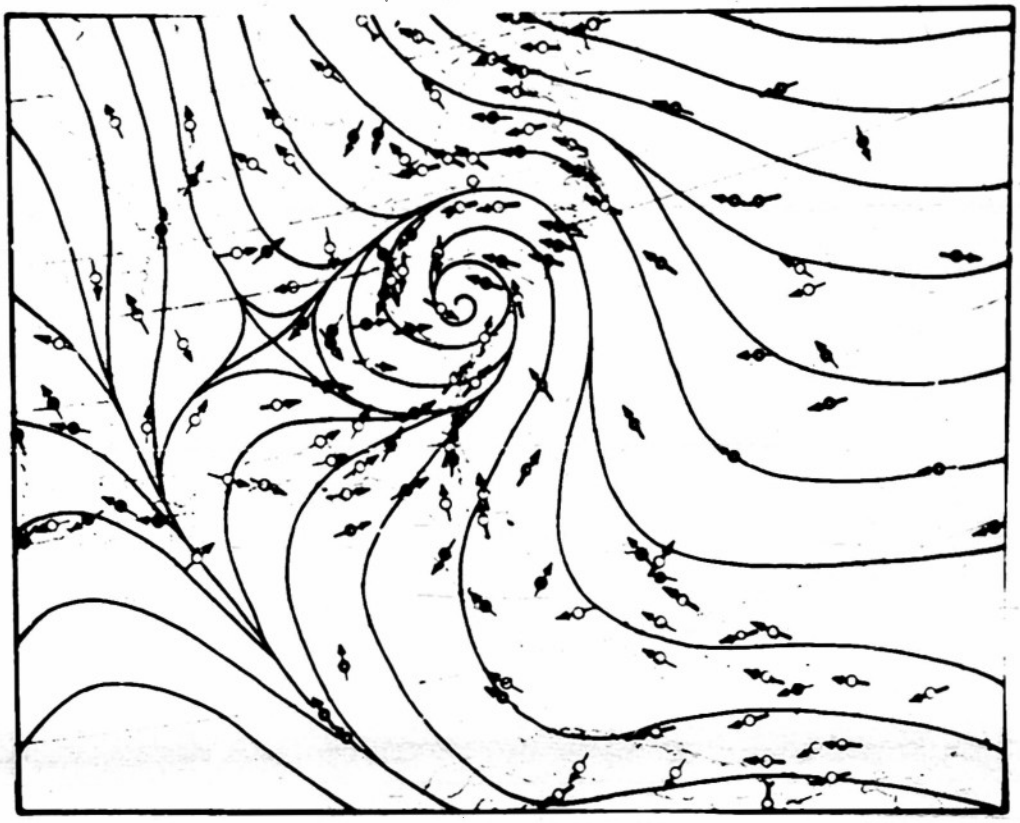
1830 GMT AUGUST 30



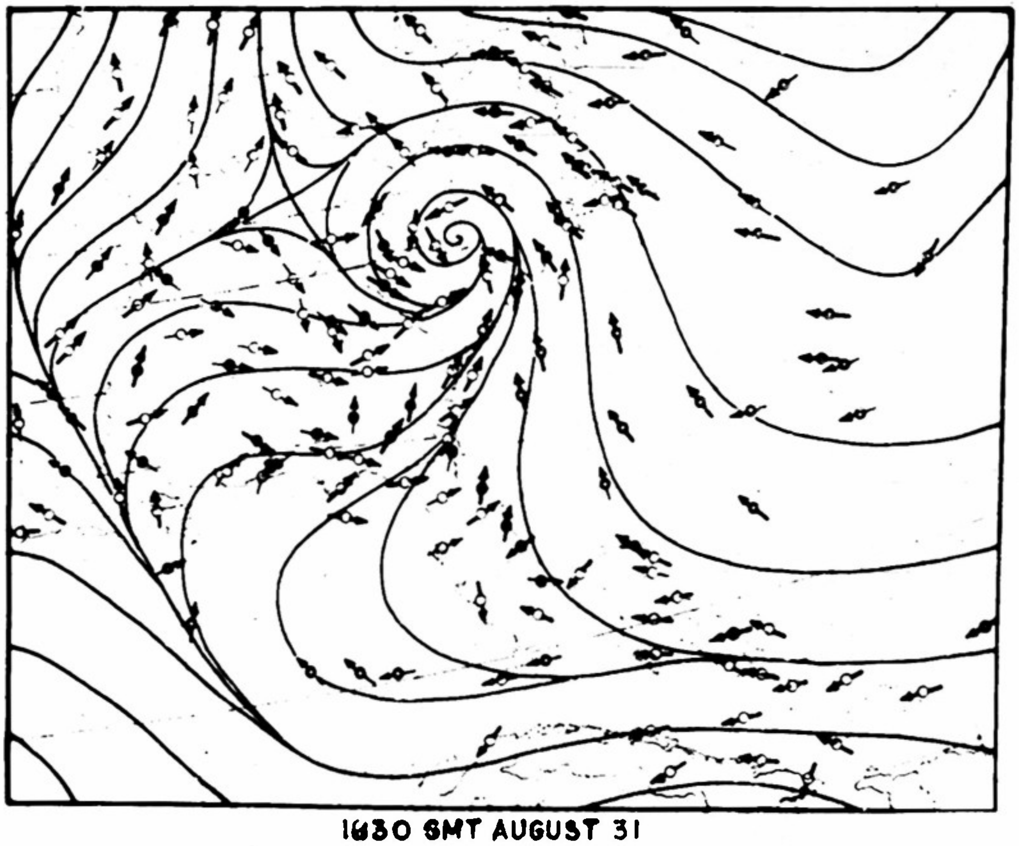
0030 GMT AUGUST 31



0630 GMT AUGUST 31

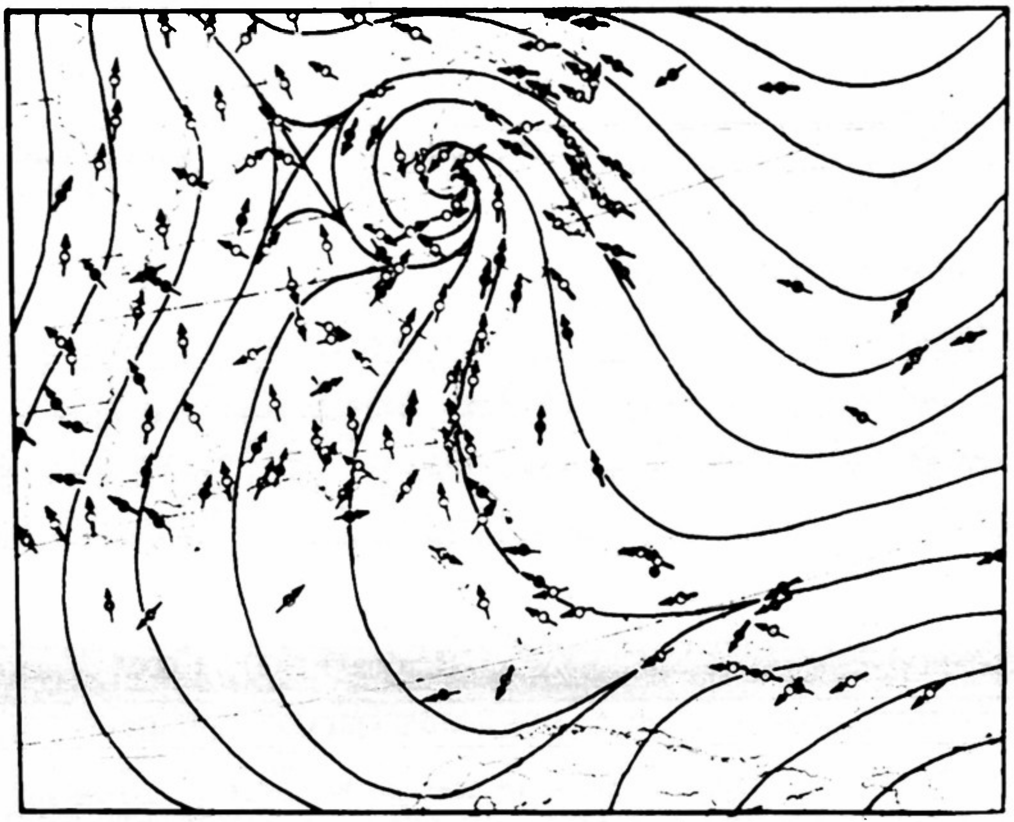


1230 GMT AUGUST 31



1630 GMT AUGUST 31

0030 GMT SEPTEMBER 1



LEGEND:

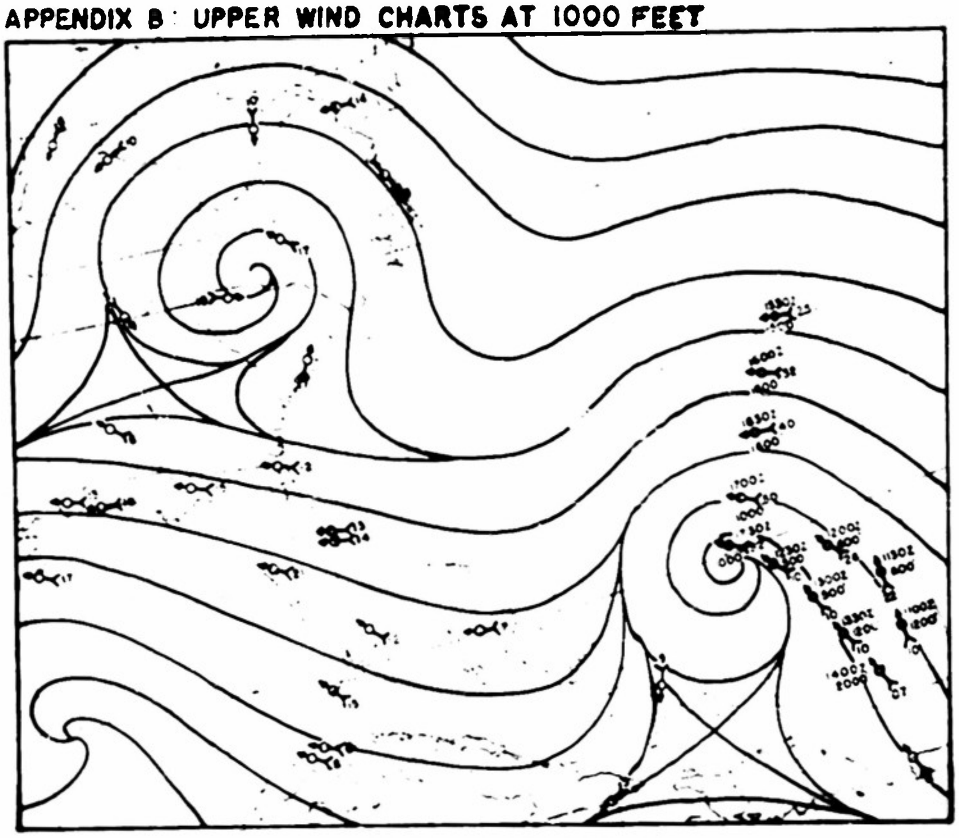
- ○ land stations reporting wind direction to the nearest 10 degrees
- ● land stations reporting wind direction to 16 points of the compass
- ⊙ ship wind reports to nearest 10 degrees
- ◉ ship wind reports to 16 points of the compass
- ↓ wind speed greater than 8 knots
- ↓ wind speed of 8 knots or less
- © calm

Appendix B (1000 ft. level charts)

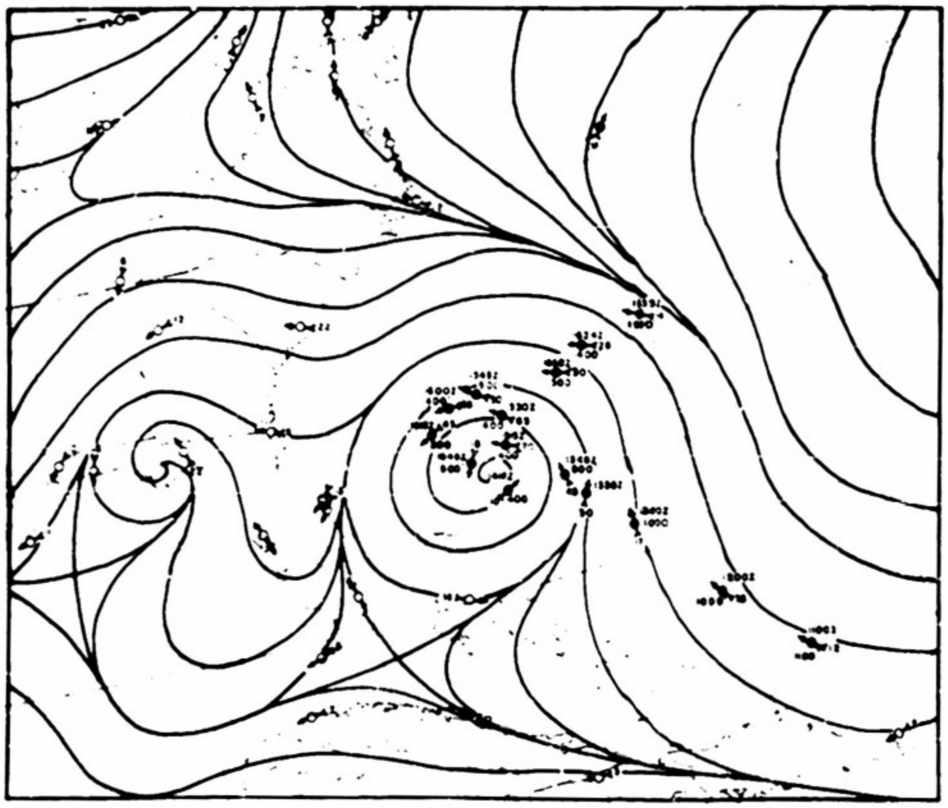
August 28 (1500Z) The wind reports at Mayaguana Island (22° 21'N 72° 50' W) and Guantanamo, Oriente (19° 54' N 75° 09' W) Port-au-Prince (18° 33'N 72° 21' W) fixed fairly well the southern sector of the asymptote of convergence, as well as the northern section of the asymptote of divergence. The south-southeasterly flow at Ramey Air Force Base at Puerto Rico (18° 30' N 67° 08' W) aided in fixing the position of the southern sector of the asymptote of divergence. The extrapolated wind reports of the reconnaissance aircraft determined the eastern limit of the northern section of the asymptote of convergence. By integrating those known locations, the hyperbolic point was located. Note that there is hardly any slope of the hyperbolic point from the surface up to 1000 ft (see figure 3).

August 29 (1500Z) The easterly flow south of the hyperbolic point is clearly indicated by the wind reports of Havana (23° 09'N 82° 21' N), Guantanamo, Oriente, and Port-au-Prince. The three wind reports along the eastern coast of Florida gave a good fix of the northern sector of the asymptote of divergence and the west-northwest flow at New Providence Island (25° 01' N 77° 28 W) set the western limit of the northern section of the asymptote of convergence of the cyclonic indraft point. The southern limit of the southern sector of the asymptote of divergence had been established by the predominant easterly flow over Cuba. In contrast with the position during the previous day, the hyperbolic point at 1000 ft indicates a forward slope with height from the surface.

APPENDIX B: UPPER WIND CHARTS AT 1000 FEET



1500 GMT AUGUST 28



1500 GMT AUGUST 29

1. Ross, R. B., 1952: Hurricane Able, 1952, Mo. Wea. Rev., 80, 138-143

2. Sherman, L., 1950: Appendix B to the Tenth Report of the Tropical Pacific Project, Contract W28-099 ac-385, Air Materiel Command with the U.C.L.A., 13 pps.

3. __________, 1953: A proposed Modification of Hurricane Reconnaissance Procedures, Bull. Amer. Meteor. Soc., 34,

4. Simpson, R. H., 1946: On the movement of tropical cyclons, Trans Amer Geophys. Union, 27, 650-655